Canada Alberta

FOREST RESOURCE DEVELOPMENT AGREEMENT
ENTENTE SUR LA MISE EN VALEUR DES RESSOURCES FORESTIERES

Canada Alberta

The Canada-Alberta Forest Resource Development Agreement is a subsidiary agreement of the Canada-Alberta Economic and Regional Development Agreement, which provides coordination and cooperation between the governments of Alberta and Canada in areas of Alberta's economic development.

The Canada-Alberta Forest Resource Development Agreement is funded equally by the governments of Canada and Alberta, from April 1, 1984, to March 31, 1989.

Its primary objectives are to ensure the long-term availability of timber supplies; to optimize timber uses; and to contribute to the growth and diversification of Alberta's economy.

The Agreement comprises three programs: Reforestation; Applied research, technology transfer and opportunity identification; and Public information, evaluation and administration. These programs are managed by a joint Directorate and are implemented by Forestry Canada and the Alberta Forest Service.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est auxiliaire à l'Entente Canada-Alberta sur le développement économique et régional, qui vise à assurer la coordination et la coopération des deux gouvernements relativement au développement économique de l'Alberta.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est financée à parts égales par les gouvernements du Canada et de l'Alberta, et a cours du 1er avril 1984 au 31 mars 1989.

Ses objectifs principaux sont assurer la disponibilité à long terme de réserves de bois; optimiser leur utilisation; et contribuer à la croissance et la diversification de l'économie de la province.

L'Entente comprend trois programmes: Reboisement; Recherche appliquée, transferts de connaissances techniques et relevé des occasions; et Information, évaluation et administration. Ces programmes sont gérés par un Bureau de direction conjoint, et mis en oeuvre par Forêts Canada et le Service forestier de l'Alberta.

For more information, please call or write:

Pour de plus amples informations, veuillez vous adresser à:

Forestry Canada
Northern Forestry Centre
5320 - 122 Street
Edmonton, Alberta
T6H 3S5
Telephone: (403) 435-7210

OR/OU Alberta Department of
Forestry, Lands & Wildlife
9915 - 108 Street
Edmonton, Alberta
T5K 2C9
Telephone: (403) 427-3583

92-04069/

Promotions and Presentations

Forestry Department
Alberta Research Council[1]

1990

This is a joint publication of Forestry Canada
and the Alberta Forest Service pursuant to the
Canada-Alberta Forest Resource Development Agreement

[1]Edmonton, Alberta

Project # T1B99A20-93

DISCLAIMER

The study on which this report is based was funded in part under the Canada/Alberta Forest Resource Development Agreement.

The views, conclusions and recommendations are those of the authors. The exclusion of certain manufactured products does not necessarily imply disapproval nor does the mention of other products necessarily imply endorsement by Forestry Canada or the Alberta Forest Service.

(c) Minister of Supply and Services Canada 1991
Catalogue No.: **FO 42-91/89-1991E**
ISBN: **0-662-18497-1**

Additional copies for this publication are available at no charge from:

Forestry Canada
Regional Development
5320 - 122nd Street
Edmonton, Alberta
T6H 3S5
Telephone: (403) 435-7210

or

Forestry, Lands and Wildlife
Forest Industry Development Division
108th Street Building
#930, 9942 - 108th Street
Edmonton, Alberta
T5K 2J5
Telephone: (403) 422-7011

Summary

The aim of promotions and presentations is to inform the forest products industry and related agencies about the Research and Development program carried out at the Alberta Research Council's Forest Products Laboratory. The major thrust for this year was the publication of four scientific/technical reports and the presentation of these publications to scientific/technical/industrial audiences.

Specifically, the following reports/presentations were prepared and given:

- Development of the Alberta Research Council's Forest Products Program During the First Canada-Alberta Forest Resource Development Agreement (1984/85 to 1989/90) (*prepared as an ARC Special Report)

- Alberta Research Council Panel Pilot Plant Press Line Capabilities (*prepared as an ARC Special Report)

- Flexural Properties of Corrugated Waferboard (*Technical Forum presentation at the 23rd International Particleboard/Composite Symposium at Washington State University)

- Structural Wood-Base Panel Performance Bending Test Methods and Particle Alignment Effects (*Presented at the Pacific Timber Engineering Conference in Auckland, New Zealand)

Acknowledgements

The financial contribution to the Alberta Research Council's Forest Products Research and Development Program from the Alberta Forest Service (Alberta Forestry) and Forestry Canada through the Canada-Alberta Forest Resource Development Agreement is greatly appreciated.

TABLE of CONTENTS

1. **INTRODUCTION** 1
   - 1.1 **Goals and Objectives** 1
   - 1.2 **Background** 1
   - 1.3 **Contribution to the Development of Alberta Forests** 2
   - 1.4 **The Importance of Publication of Results** 2
   - 1.5 **Methods** 2

2. **ACTIVITY** 2
   - 2.1 **Publications** 3
   - 2.2 **Forest Products Laboratory Capabilities** 3

3. **CONCLUSIONS** 4
   - 3.1 **1989/90 Objectives** 4
   - 3.2 **Technical Leadership** 4
   - 3.3 **Business Development** 4

4. **RECOMMENDATIONS** 4

LIST of APPENDICES

Appendix A Schedule "A", Description of Services, C-A FRDA Contract 1989/90 6

Appendix B Technical Forum Presentation: Flexure Properties of Corrugated Waferboard presented at the Twenty-Third International Particleboard/Composite Materials Symposium April 1989 7

1. INTRODUCTION

1.1 Goals and Objectives

The goal of this project is to inform the forest products industry and related agencies about the research achievements of and the services provided by the Forest Products Program.

Specific objectives for the year include:

1. To prepare four scientific papers in the following areas based on work that was previously carried out for the Minister; example:

   - ARC 4' x 8' press (RMC Implementation)
   - Binder Testing
   - Short Term Assistance
   - Codes and Standards of Foreign Markets
   - A report describing the testing laboratory and the pilot plant under the C-A FRDA.
   - A report describing the development of the testing laboratory and the panel pilot plant under C-A FRDA.

2. These papers shall be submitted for publication to one of the following:

   - Special ARC Report
   - Forest Products Journal, or
   - Wood Science, or
   - similar quality journals.

3. Some of these papers shall be presented to a scientific/industrial audience such as:

   - Annual Meeting of the Forest Products Research Society (FPRS), including poster sessions.
   - International Particleboard Composite Materials Symposium, including poster sessions.

1.2 Background

The promotions and presentations activities of the Forest Products Program serve to inform the industry, government and the public of the technical and scientific level and activities of the program. Further, such activities serve to promote:

- the ongoing forest products research and development program carried out by the Alberta Research Council,

- specific technologies that have reached the point where they should be transferred to industry, and

- the contract services provided to industry by the Testing Laboratory and the Panel Development Laboratory.

1.3 Contribution to the Development of Alberta Forests

The Alberta Research Council has made specific contributions to the development of the Alberta Forests particularly through work in the development of oriented strandboard and structural components. Such contributions are expected to continue and may be extended to the development of new innovative products.

1.4 The Importance of Publication of Results

Through the development of the Forest Products Testing Laboratory and the Panel Development Laboratory the Alberta Research Council can provide unique facilities and skills for assisting industry in the development and testing of engineering wood composites. But reputation is built upon scientific and technical excellence. Thus the standard of services offered to industry by the Forest Products Laboratories must be continuously exposed to peer review and industry scrutiny.

Further, for reasons of accreditation and recognition by national and international bodies, the maintenance of technical and scientific standards must be established and maintained at prevailing levels or better. Publication of results is an important factor in achieving this objective.

1.5 Methods

The methods used in promotions and presentations include:

- presentations at trade shows, conferences, seminars, etc.,
- publications in technical and scientific journals, and
- lectures, including summaries and reprints.

In 1989/90 specific emphasis was placed upon the publication of technical papers based upon the results of prior research.

2. ACTIVITY

The following is a summary of the present state of progress of "Presentations and Promotions" project according to the Alberta Research Council and C-A FRDA

description of services contract outlines in Schedule "A" (Appendix A) to December 31, 1989.

2.1 Publications

Dr. Lars Bach gave a poster presentation entitled **"Flexural Properties of Corrugated Waferboard"** at 23rd International Particleboard/Composite Symposium in Pullman, Washington. For his part, Lars Bach was awarded an Appreciation Award from Washington State University. A copy of the sections of the poster display are given in Appendix B.

A paper entitled **"Structural Wood-Base Panel Performance, Bending Test Methods and Particle Alignment Effects"** was presented at the Pacific Timber Engineering Conference in Auckland, New Zealand by Mr. Robert Wellwood. This paper was based on two projects carried out in cooperation between ARC and the US Forest Products Laboratory in Madison, Wisconsin. Five copies have been submitted under separate cover.

A poster presentation outlining ARC's **Forest Products testing and R&D capabilities** was displayed at the Northern Mixedwood '89 conference in Fort St. John, B.C.

A presentation entitled **"Forest Sector R&D Programs at the ARC - Past and Future"** was given to the Alberta Forest Products Association at their annual meeting by Mr. Peter Williams.

A poster presentation outlining ARC's **Forest Products testing and R&D capabilities** was displayed at the Canadian Institute of Forestry's annual meeting in Kananaskis, Alberta.

Two ARC special reports were written. The first, entitled **"Development of the Alberta Research Council's Forest Products Program During the First Canada-Alberta Forest Resource Development Agreement (1984/85 to 1989/90)"** summarized the position of the ARC Forest Products Program in 1990 in comparison to 1984. The second, entitled **"Alberta Research Council Panel Pilot Plant Press Line Capabilities"** summarizes the available equipment and capabilities of the pilot plant. Both of these reports emphasize the major developments that were accomplished at ARC due to project funding by the Canada-Alberta Forest Resource Development Agreement. Five copies of each have been submitted under separate cover.

2.2 Forest Products Laboratory Capabilities

Various presentations were made throughout the contract period as follows.

Organization	Format	Location	Date
Canadian Institute of Forestry	poster session	Kananaskis, Alberta	October 15-21, 1990
Forestry Canada	slide presentation	Hull, Quebec	October 30, 1990
1st Annual Alberta Forestry Show	display booth	Edmonton, Alberta	October 25-26, 1990
C-A FRDA B4 Committee	seminar	Edmonton, Alberta	December 21, 1989
Northern Mixedwood Conference '89	display booth	Fort St. John, B.C.	September 12-14, 1989
Alberta Forest Products Association AGM	poster session	Jasper, Alberta	September 28-29, 1989

3. CONCLUSIONS

3.1 1989/90 Objectives

The promotion and presentation activities of the Forest Products Program for the year 1989/90 have achieved their objectives.

3.2 Technical Leadership

Promotions and presentations expose the scientific community to the technical achievements of the forest products program. As such they are critical to the positioning of the forest products program within the national and international scientific community.

3.3 Business Development

Promotions and presentations expose the technical and scientific community to the quality and range of programs and services offered by the Forest Products laboratories. Consequently, promotions and presentations can be considered to be a powerful business development tool for the development of new contracts by the forest products laboratories of the ARC.

4. RECOMMENDATIONS

It is recommended that the activity be continued into the 1990/91 fiscal year and that the scope of the work be increased to include:

1. Presentation of papers, reports, etc. at scientific and technical conferences, meetings, seminars, etc.

2. Publication and coverage of program activated in the scientific and technical media.

3. Attendance at trade shows and meetings, in particular the AFPA and FPRS annual general meetings.

4. Revision of existing promotional material to reflect progress to date and the increased scope of the Forestry Program at the ARC.

5. Consideration of joint presentations/activities with the Alberta Department of Forests, Lands and Wildlife, and other cooperating organizations and agencies e.g. Forintek, FERIC, U of A, etc.

Appendix A

Schedule "A"
Description of Services
C-A FRDA Contract 1989/90

S C H E D U L E "A"

Description of Services

1. The Research Council shall perform and deliver the services according to the following description, terms, conditions, standards, requirements and provisions.

   The Research Council shall undertake the following work regarding the promotion associated with the publication and presentation of 4 reports:

   I. A scientific technical paper shall be prepared in the following areas based on the work that was done previously for the Minister; example:

      a) ARC 4'x8' press (RMC Implementation)

      b) Binder Testing

      c) Short Term Assistance

      d) Codes & Standards or Foreign Markets *

   II. These papers shall be submitted for publication to one of the following:

      a) Special ARC report,

      b) Forest Products Journal,

      c) Wood Science,

      d) Similar quality journals.

   III. Some of these papers shall be presented to a scientific/-industrial audience such as:

      a) The Annual Meeting of FPRS, including poster sessions,

      b) The International Particleboard Composite Materials Symposium, including poster sessions, etc.

*I. e) A report describing the development of the testing laboratory and the panel pilot plant under C/A FRDA

.../2

Schedule "A" (cont'd)

IV. Prepare progress and final reports in accordance with Schedule "C".

V. The project will be audited in accordance with Schedule "D."

VI. If changes are required to the contract they shall be made in accordance with Schedule "E".

Note: All presentations and papers should clearly acknowledge the financial contribution of the Canada/Alberta Forest Resource Development Agreement.

Appendix B

Technical Forum Presentation:
Flexure Properties of Corrugated Waferboard
presented at
The Twenty-Third International Particleboard/Composite
Materials Symposium, April 1989

PROCEEDINGS OF THE TWENTY-THIRD
WASHINGTON STATE UNIVERSITY

INTERNATIONAL PARTICLEBOARD/COMPOSITE MATERIALS SYMPOSIUM

April 4, 5, 6, 1989

Edited by
Thomas M. Maloney
Wood Materials and Engineering Laboratory

Associate Editor
Lucille H. Leonhardy

Graphics Editor
Martin T. Lentz

Photography
Glenn Sprouse

Sponsored by
Wood Materials and Engineering Laboratory
and
Conferences and Institutes

College of Engineering and Architecture

Pullman, Washington

1989

Flexure Properties of Corrugated Waferboard

Lars Bach
Alberta Research Council
Edmonton, Alberta
CANADA

The inherent disadvantages of conventional planar wood panels such as waferboard, OSB, and plywood lie in their relatively low structural stiffness and strength. The Alberta Research Council is developing a corrugated panel called Waveboard™ to improve the longitudinal flexural stiffness and strength characteristics of traditional waferboard panels. Using corrugated waferboard, technically new applications for subflooring, roof sheathing, and webs for stressed skin panels are possible. Many decisions will have to be made with regard to choice of panel profile. Mathematical models are used extensively to save the time and money used previously for experimental panel manufacture testing. The theoretical flexure stiffness and load capacity of Waveboard are estimated in advance using standard engineering mechanics principles, assuming the same specific material properties as for flat waferboard. A computer model that uses numerical integration subroutines to evaluate the influence of changing geometric panel parameters such as panel depth, skin thickness, and wavelength has been developed. It is based on the assumption that the specific panel density remains constant. Model calculation results for various theoretical corrugated panels with sinusoidal profiles will be presented. Comparisons with results of tests on actual corrugated waferboards show good agreement. For commercialization purposes, it is important to predetermine whether or not the flexural performance of a suggested new profile for Waveboard™ will fulfill given requirements. In addition, it is economically significant because construction of the special Waveboard™ press platens required for making most new profiles is very costly.

Flexure

Properties of

Corrugated

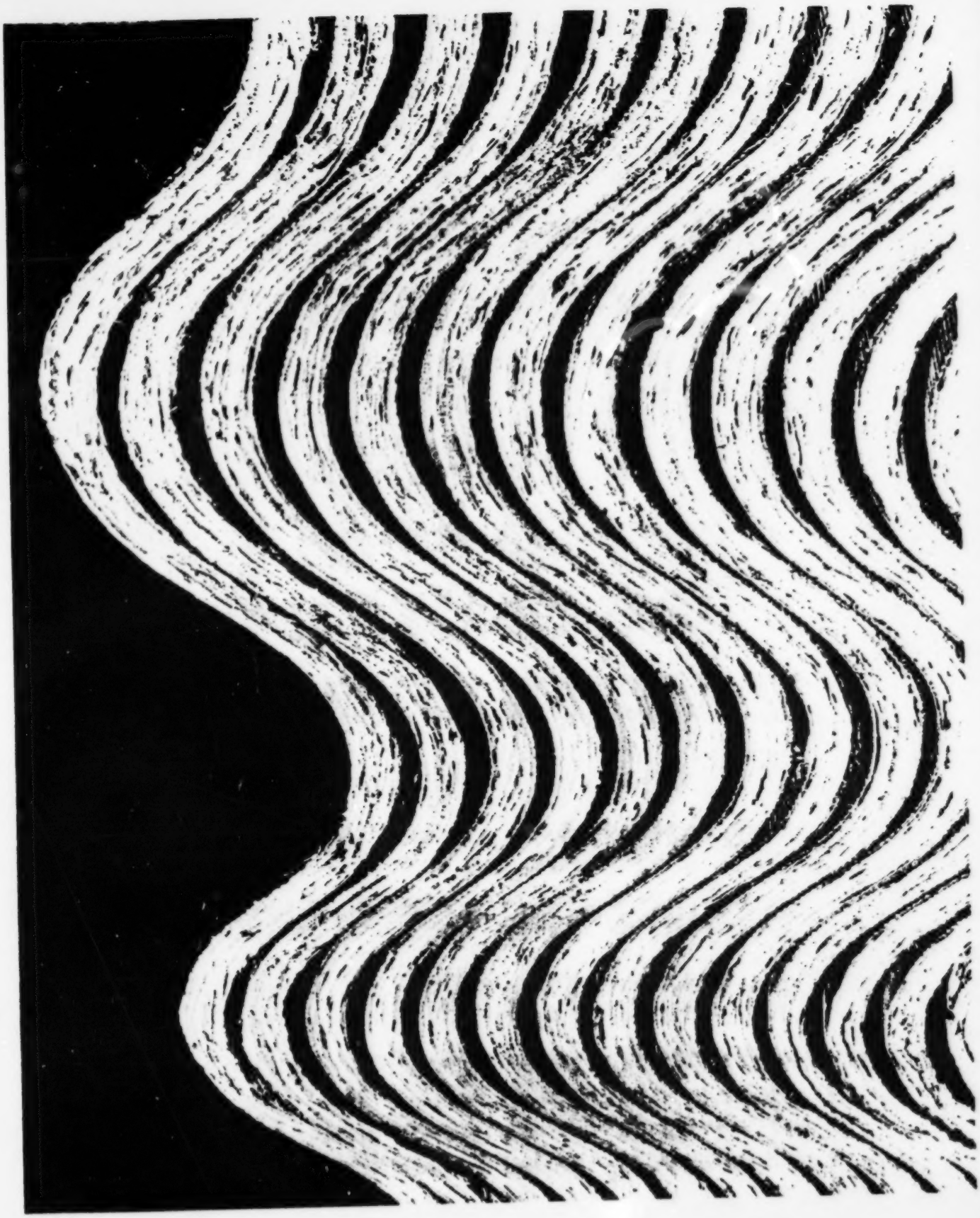
Waferboard

Abstract

A disadvantage of conventional planar wood panels such as waferboard, OSB and plywood lies in their relatively low structural stiffness and strength.

As it is important to predetermine whether or not the flexural performance of a suggested new profile will fulfill given requirements, model calculations for various theoretical corrugated panels with sinusoidal profiles are presented.

Comparisons of theoretical calculations with results of tests on actual waferboards show good agreement.



Panel Profiles Possible

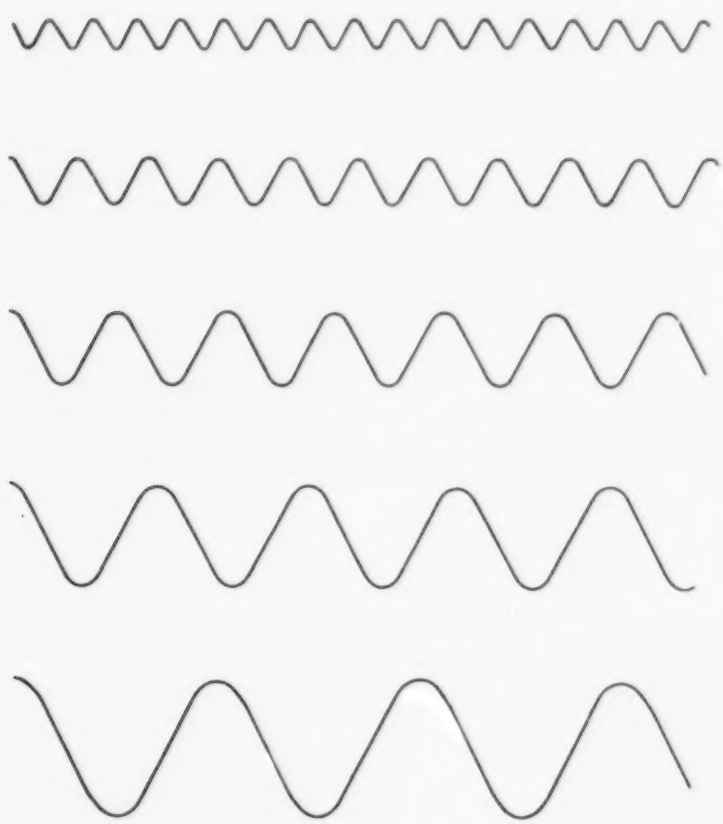
High profile flat top corrugated waferboard.

Sinusodial corrugated waferboard.

Low profile flat top corrugated waferboard.

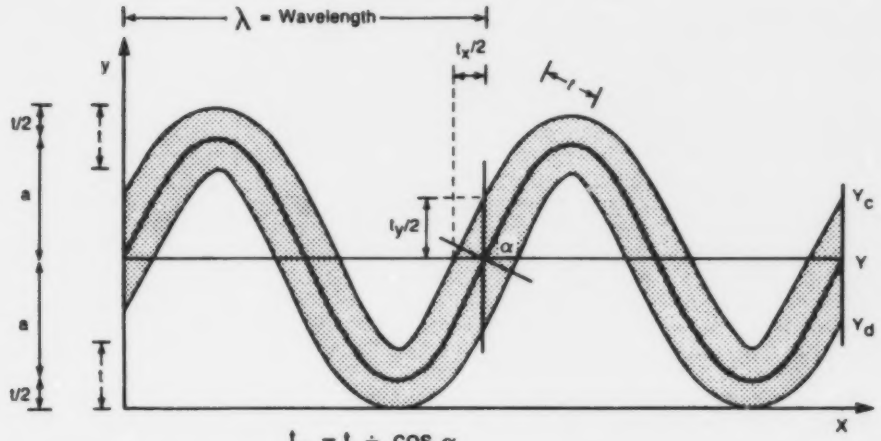
Ordinary flat waferboard

Figure showing the centerlines on corrugated panels with increasing amplitude.



Theoretical

Cross Section of Corrugated Panel with Sinusodial Panel Center and Constant Normal Thickness



$$t_y = t \div \cos \alpha$$

$$t_x = t \div \sin \alpha$$

$$\alpha = \tan^{-1} \left[a \cdot \frac{2\pi}{\lambda} \cos \left(\frac{2\pi}{\lambda} \cdot x \right) \right]$$

$$Y_c = \left(a + \frac{t + t_y}{2} \right) + a \cdot \sin \left(\frac{2\pi}{\lambda} \cdot x \right)$$

$$Y = \left(a + \frac{t}{2} \right) + a \cdot \sin \left(\frac{2\pi}{\lambda} \cdot x \right)$$

$$Y_d = \left(a + \frac{t - t_y}{2} \right) + a \cdot \sin \left(\frac{2\pi}{\lambda} \cdot x \right)$$

Cross Section Area (A)

$$A = \int_0^{\lambda} (Y_C - Y_d)\, dx$$

where:

Y_C = curvature of upper surface section with reference to X-axis touching lower surface peaks

Y_d = curvature of lower surface section with reference to X-axis touching lower surface peaks

λ = wavelength

Moment of Inertia (I)

$$I = \frac{1}{3} \int_0^{\lambda} (Y_C^3 - Y_d^3)\, dx - A \cdot (a + \frac{t}{2})^2$$

where:

a = amplitude of the sinusodial center line of the skin

t = skin thickness measured as normal to the sinusodial center line

Section Modulus (S)

$$S = I/(a + \frac{t}{2})$$

---

if:

E = Modulus of Elasticity
MOR = Modulus of Rupture
w = Subscript (Waveboard)
f = Subscript (Flatboard)

We have:

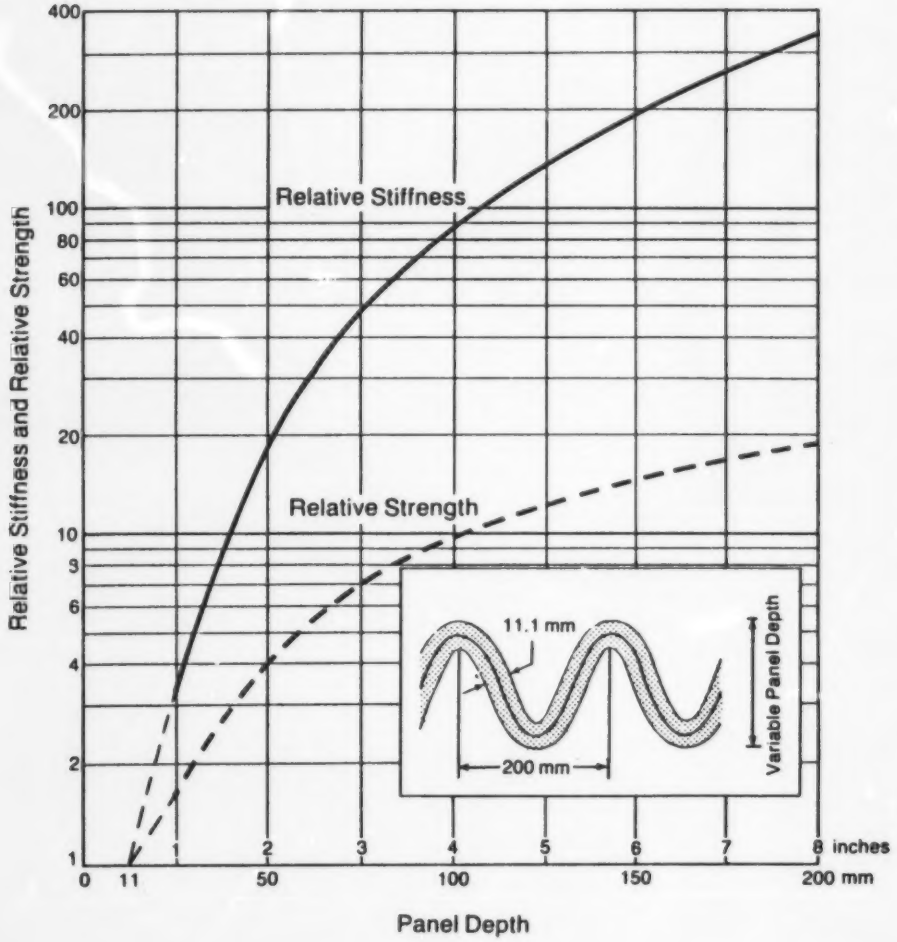
Relative stiffness

$$\frac{E_w \cdot I_w}{E_f \cdot I_f} \cong \frac{I_w}{I_f}$$

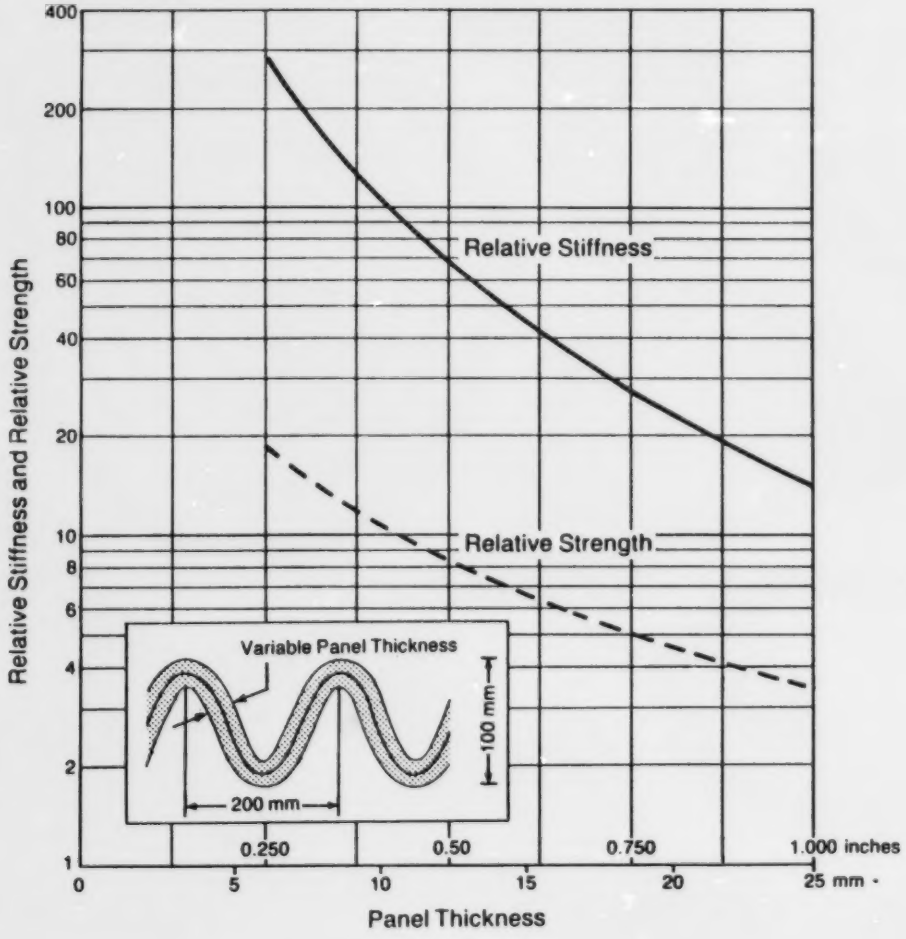
Relative strength

$$\frac{MOR_w \cdot S_w}{MOR_f \cdot S_f} \cong \frac{S_w}{S_f}$$

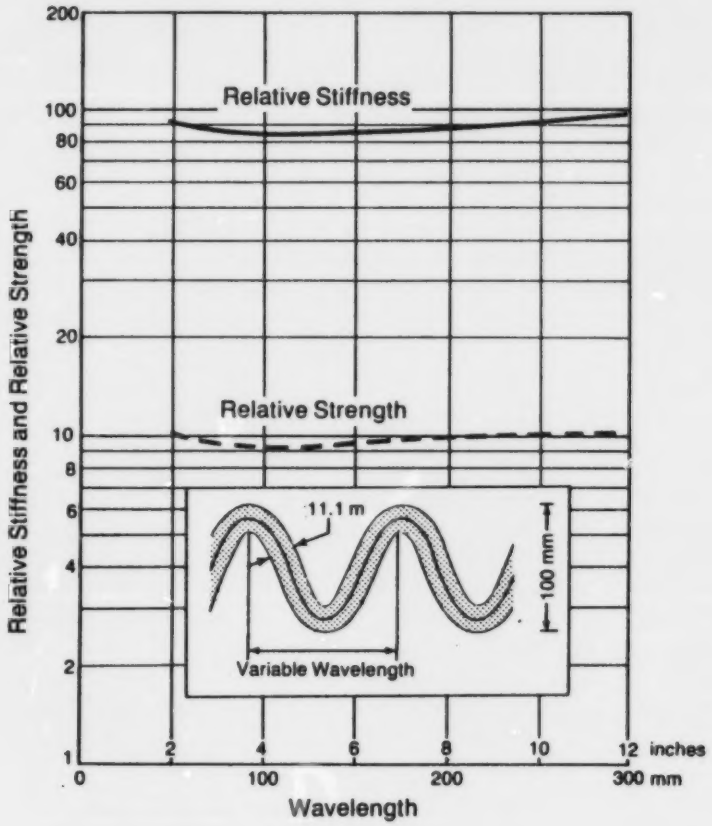
Bending Stiffness and Strength of Waveboard with Increasing Panel Depth, Relative to Flat Panels



Bending Stiffness and Strength of Waveboard With Increasing Panel Thickness, Relative to Flat Panels



Bending Stiffness and Strength of Waveboard with Increasing Wavelength, Relative to Flat Panels



Experimental

Panel properties	Sinusoidal corrugated waferboard	Ordinary flat waferboard	Ratio "sinusodial to flat"
Panel density (kg/m³)	647	665	0.97
Unit panel mass (kg/m²)	8.6	7.7	1.12
Wavelength (mm)	188	-	-
Panel depth (mm)	65	11.6	5.6
Skin thickness (mm)	11.2	11.6	0.97
MC (%)	4.1	3.6	-
Unit max. moment (Nmm/mm) Bending strength	4000	587	6.8
Unit EI (Nmm²/mm) Bending stiffness	20,400,000	724,000	28.2
Cross section (mm²/mm)	13.2	11.6	1.14
Section modulus (mm³/mm)	142	22.4	6.3
Moment of inertia (mm⁴/mm)	4626	130	35.6
Modulus of rupture (MPa)	28.2	26.2	1.08
Modulus of elasticity (GPa)	4.41	5.57	0.79

The Alberta Research Council acknowledges the financial contributions of the Canada-Alberta Forest Resource Development Agreement for major parts of this study.